THE MALAWI NATIONAL EXAMINATIONS BOARD

2024 MALAWI SCHOOL CERTIFICATE OF EDUCATION EXAMINATION

CHIEF EXAMINER'S REPORT

PHYSICS (M164/1 & II)

General Comments On:

A. Quality of the Paper

Paper 1 (Theory)

The 2024 Physics Paper I compared favourably with the previous examination papers. The paper had no typo–errors and the language used was appropriate for the level of the candidates. It examined a wide range of scientific skills based on the Blooms Taxonomy with a balanced coverage of the core elements in the Senior Secondary School syllabus in terms of the level of difficulty of the questions. Among others, the rubric was clear and appropriate. The questions were clear to the tasks. Candidates were tested in a variety of skills, among others, definition of terms, interpretation of diagrams, drawing of diagrams, manipulation of figures, reasoning ability.

Paper II (Practice)

The 2024 MSCE Physics Paper II examination was relatively fair in terms of level of difficulty as most candidates scored above average. Both the language used and the test items included were appropriate for MSCE candidates. The paper compared well with Physics Paper II past papers in terms of its quality. The paper had both face and content validity with no grammatical and typographic errors.

B. Performance of Candidates

Paper I

The general performance of the candidates was average with a reduction in the candidates that got a null score as compared to the 2023 paper. However, some had problems in expressing themselves using scientific vocabulary, manipulation skills, spellings and application of concepts. Responses on the individual questions displayed some of the shortfalls. For example, other candidates had challenges with mathematical calculations and logical presentation of facts.

Paper II

The general performance on the paper was above average mostly candidates from national, district and conventional secondary schools unlike those from community day secondary schools who performed below average. Some candidates demonstrated lack of skills of data analysis and interpretation of results.

C. Candidates Performance on Individual Questions

PAPER 1 (THEORY)

Section A

Question 1a

The question asked the candidates to give any two sources of zero errors. The question was well performed by many candidates. The expected responses were using faulty or damaged instruments; incorrectly calibrated instruments and instruments not reset to zero. Some candidates however, failed because they gave types of error (random, systematic, etc); while others stated wrong observation of zero on the instrument as well as poor positioning of the eye when taking the reading.

Question 1b

The question demanded candidates to state any two methods of communicating results of an experiment. Some of the correct responses were: oral presentations, written reports, posters and video conferencing. However, some candidates failed because instead of focussing on ways of

communicating results, they stated ways of presenting data for analysis such as charts, tables, graphs. Others wrote "Verbal and Non–verbal communication as their answer, which was wrong.

Question 1c (i)

Candidates were asked to state the relationship between frequency and length of pendulum using the information shown by the graph in **Figure 1**. Many candidates managed to give the correct response as "inverse relationship" or "when the length of pendulum increases the frequency decreases". Some candidates failed because they stated in such a way that length of pendulum is dependent on the frequency i.e. when frequency decreases the length increases or vice versa.

Question 1 c (ii)

The question demanded the candidates to find the frequency when the length of the pendulum was 25 cm. The correct response was that after doing interpolation, the frequency of the pendulum for the given length of 25cm was supposed to be 0.25 Hz. Those who failed gave wrong answers like 0.25 cm; 0.24 Hz; $0.2\frac{1}{2}$ Hz and 0.2.5 Hz due to poor analytical skills.

Question 2 a

Candidates were asked to define the term 'absolute zero temperature'. This was a popular question and many candidates managed to get it correct. However, some candidates failed because they gave the general definition of temperature as being the degree of hotness or coldness of a substance instead of writing it as 'the lowest possible or attainable temperature of a substance at which molecular motion stops.

Question 2 b

The question demanded the candidates to calculate the pressure exerted when hydrogen gas of volume 8 cm^3 exerts a pressure of 6 atm at 27 ^{0}C given that its volume is doubled and heated to 127^0 C. Those who got it right managed to get 2.25 atm after using the general/universal/combined gas law equation. Thus $\frac{\boldsymbol{P_1 \times V_1}}{\boldsymbol{T_1}}=\frac{\boldsymbol{P_2 \times V_2}}{\boldsymbol{T_2}}$**.** Some candidates failed

because they squared 8 cm^3 volume to 64 cm^3 instead of doubling it to 16 cm^3 and failed to convert the given temperature values to Kelvin.

Question 2 c

The question asked the candidates to give the three factors that affect pressure. Majority of the candidates gave correct answers. The expected answers were depth/height of the liquid; density of the liquid and gravity. Those candidates who failed stated properties of liquid pressure or just properties of liquids, volume, shape of container and viscosity. Some could write wrong spellings such as delth instead of depth.

Question 3 a (i)

Candidates were asked to identify the state of matter which has the highest density using the illustration in **Figure 2**. A good number of candidates were able to identify **X** as the state of matter with the highest density. However, those who failed could state "solid" instead of **X**.

Question 3 a (ii)

The question asked the candidates to give a reason for the answer in **Question 3 a (i)**. Most candidates got it correct. The expected response was that in **X** the particles are closely/tightly packed together hence high density. However, some candidates failed because they gave responses such as "it is because the particles are tiny/small" or "it has a definite shape".

Question 3 b

The question required the candidates to explain why gaps are left between panels when constructing a brick fence. The question was popular and most candidates performed very well. The expected correct response was "to provide for free expansion and contraction of the building material" during hot and cold weather respectively in order to prevent cracking and collapsing of the fence. Some candidates failed because they gave irrelevant responses like "to allow air/sunlight to pass/penetrate through the gaps freely and to control/resist expansion".

Question 4 a

Candidates were asked to explain the energy work theorem. Many candidates got it correct. The expected response was that "work done by net force on a rigid body is equal to the change in the kinetic energy of the body". Those who failed stated the law of conservation of energy and it was wrong.

Question 4 b (i)

The question demanded the candidates to name the behaviour of water shown by the graph in **figure 3**. Most candidates did well. The candidates were expected to describe the behaviour as the "anomalous /abnormal expansion" of water. However, a few candidates failed because they described it as "abnomalous or bad behaviour" of water.

Question 4 b (ii)

The question asked the candidates to give any two problems caused by the behaviour named in Question 4 b (i). Majority got it correct. Some of the correct answers expected were "bursting of water pipes; freezing of lakes; blockages of water pipes and breakage of bottles of water in freezers. Some candidates however presented effects of the anomalous behaviour of water. It has to be noted though that some effects are problems as well.

Question 4 c

Candidates were asked to explain why an object falling in a vacuum does not reach its terminal speed. Although the question was attempted by many candidates, only few candidates got it correct. The correct response was that it does not experience air resistance and up thrust but accelerates downwards due to gravity. Those who failed gave irrelevant responses such as; the object is too heavy than the vacuum, the object has a high density than the vacuum and because as temperature increases, speed also increases.

Question 5 a

The question demanded the candidates to mention any two factors that affect the terminal velocity of an object falling into a fluid. Although the question was popular and a few candidates got it correct. The expected responses were: speed of the falling object, size/surface area of the

object and mass of the object. Those who failed gave wrong responses such as up thrust, air resistance, liquid pressure and gravity.

Question 5 b

Candidates were requested to calculate the force required to stretch a spring through a distance of 0.25 m if it has a constant of 200 N/m. A few candidates got it correct. The correct answer was 50 N. However, most candidates failed because they used wrong formulae like Work = Force × Distance or Distance × *ke*; Force = Distance × time; instead of Force = *ke* to get 50 N after proper substitution and calculations.

Question 5 c (i)

The question asked the candidates to calculate the force **F** when a block was being pulled by a force **F** on a smooth horizontal surface at an angle of 60 ^{0} with respect to the 30 N due East as shown in **Figure 4**. A few candidates got it correct. The correct answer was 60 N. Those candidates who failed used wrong formulae such as **F** = 30 N x Cos 60^{0} and **F** = Cos 60^{0} instead of writing the formula as F = $\frac{30N}{Cos\ 60^{0}}$ due to poor masterly of the content.

Question 5 c (ii)

Candidates were required to explain how the force **F** could be affected if the surface used was rough. Few candidates managed to get it right. The expected response was that force F would increase in order to overcome the amount of friction force that would arise. There were some who lost some marks because they only stated that force F would increase without giving the reason. Those who failed gave wrong responses like stating that, the force increases in order to lift the load and when the object moves to the east the angle 60° would decrease. Such responses indicated poor mastery of content of the question.

Question 6 a

The question demanded the candidates to state any two applications of Hooke's law. The question was popular and many candidates got it correct. Some of the expected responses were: used in calibration of spring balances; shock breakers/absorbers in car suspension; making rubber bands; making spring beds/diving boards; in trampoline equipment; etc. Those who failed stated what the law says e.g. the force needed to extend or compress a spring by some distance is proportional to the load applied to it instead of giving its applications.

Question 6 b (i)

Candidates were asked to identify the actual length of the spring using the information provided in **Table 1**. Most candidates got it correct and the expected answer was 17cm thus considering the un-stretched length at its initial position where the force is zero. However, some candidates wrote 24 cm instead of 17 cm due to lack of understanding and poor interpretation/analysis of the information.

Question 6 b (ii)

Candidates were requested to calculate the value of **X** (Load) when the length of the spring was 24 cm i.e. using the information provided in Table **1**. Few candidates did well and the expected answer was 63 N. However, some candidates failed because they failed to come up with the correct formula (F = *ke*; where *k* = 9. Then, F = 9 × (24 – 17) = 63N) and do proper substitution to get the expected answer.

Question 6 c

The question asked the candidates to explain the difference between natural frequency and forced vibration. Majority of the candidates failed to state that natural frequency occurs in free vibrations while forced vibrations takes place under the influence of an external force with a frequency other than its own natural frequency. However, some lost some marks because they only stated one part correctly thus failing the other to make the difference e.g. natural frequency vibrate without an external force or forced vibration is imposed by an external force.

Question 7a

Candidates were asked to define centripetal force. Few candidates got it correct. The expected correct response was that the force that acts towards the centre of a circular path. However, most candidates failed because they gave definition of a force (pull or push) as an answer instead of focussing on the demand of the question.

Question 7b

Candidates were demanded to calculate the centripetal force acting on a 2kg ball moving at a uniform speed of 10 m/s in a circular path of radius 0.8 m. A few candidates performed very well and the expected answer was 250 Kgm/s^2 or 250 N. However, most candidates failed because they did not use the correct formula; Fc = $\frac{mv^2}{r}$ (; *where* m = 2kg, v = 10m/s, r = 0.8m.)

instead they wrote formula which were not linked to the concept such as F = ma while some just wrote F = mg.

Question 7c

The question demanded the candidates to explain the way potential difference differ from electromotive force. A few candidates got it correct. The expected correct response was that potential difference (p.d.) is the work done in moving one coulomb of charge from one point to another while electromotive force (e.m.f.) is the energy available between the terminals of the cell per coulomb for a complete circuit. Those who failed gave wrong answers such as definition of work done, current and resistance. This showed that they did not understand the question.

Question 8a

The question required the candidates to explain why there is poor electrical conductivity in insulators according to the band theory. Majority of the candidates failed. The expected response was that according to the band theory, there is poor conductivity in insulators because they have a very wide forbidden gap between the valence band and the conduction band in their structure hence it is difficult for electrons to be promoted into the conduction band. For those that failed in the question gave answers such as insulators:-

- are materials that do not conduct electricity
- have large depletion layer hence poor conductivity
- have large gap between electrons hence electrons cannot jump

Question 8 b

Candidates were asked to explain the **AND** logic gate operates in a circuit. Few candidates got it correct. The expected answer was that the AND logic gate gives a high output when both input values are high, otherwise the output is low (0). Or else it switches on only when both inputs are closed (on). A good number of candidates failed because they gave answers related to OR gate. Others were not precise with their expression of the relationship between the inputs and output. For example, they could just say that the AND gate operates when the two inputs are closed. Some other candidates wrote “it gives light” and “does not give light” or “positive” and “negative” for the binary expressions of inputs and output of “1” and “0”.

Question 8 c

The question asked the candidates to explain the way the change in temperature affect the speed of sound in air. Most candidates got it right. The expected answer was that increase in temperature makes the temperature to gain more kinetic energy hence move very fast with higher speed and vice versa. This in turn decreases the density of air hence increases the velocity of the sound. Candidates, who failed, were not able to relate the changes in the way temperature affect the speed of sound and came up with responses like temperature makes the sound to be heated while some wrote temperature, make the sound hot.

Question 9 a (i)

The question demanded the candidates to identify the appliance that consumes most power given power rating of different appliances in a table. Majority of the candidates got it correct. The expected correct answer was the immersion heater although some wrote 3KW. Those who failed chose the air conditioner (600 W) because they did not recognise the higher rating difference between 3kw and 600w.

Question 9 a (ii)

The question requested the candidates to give a reason for the answer in **Question 9 a (i)**. A lot of candidates failed. They gave wrong responses such as:

- Has the highest ability to absorb heat hence low resistance
- It consumes more power
- It's power rating is in KW
- Needs a lot of power to operate.

The expected correct response was that the immersion heater consumes more power per second compared to the other appliances.

Question 9 a (iii)

Candidates were asked to calculate the amount of energy consumed by the air conditioner after switching it on for 5.5 hours. Few candidates got the question correct. The correct answer expected was 3.3 KWH. Those who failed gave wrong answers like 33 KWH while some gave 0.33KWH because they did not come up with the correct formula due to poor mastery of the content.

Question 9 b

The question demanded the candidates to state any two electrical safety measures. Majority of candidates got it correct. Some of the expected answers were: switching off or unplug/disconnect appliances when not in use, wearing protective material when working with electricity or appliances and broken plugs, keeping electrical appliances and areas around them dry and etc. some candidates failed because they stated the general laboratory safety measures e.g. following the instructions and avoiding playing in the laboratory instead of being specific to the demand of the question.

Question 10 a

Candidates were asked to give any two uses of ultrasonic sound waves. Many candidates did not attempt the questions except a few candidates who got it correct. The expected responses were: is used in examination of pregnancy to monitor baby's health, to determine the depth of deep waters, sensing motion in burglar alarms and location of hauls in fishing (echolocation). Those who failed gave irrelevant responses like they do not require a medium, travel in all direction and have rarefactions and compressions.

Question 10 b

The question required the candidates to calculate the frequency of a sound wave travelling at 375 m/s if it has a wave length of 2.5 m. A few candidates got the question correct and the expected correct value was 150 Hz. However, many candidates failed because they wrong formula; f = $\frac{\lambda}{v}$ instead of f = $\frac{v}{\lambda}$ where v is the speed of light and λ is the wavelength. This could be due to poor mastery of the content.

Question 10 c

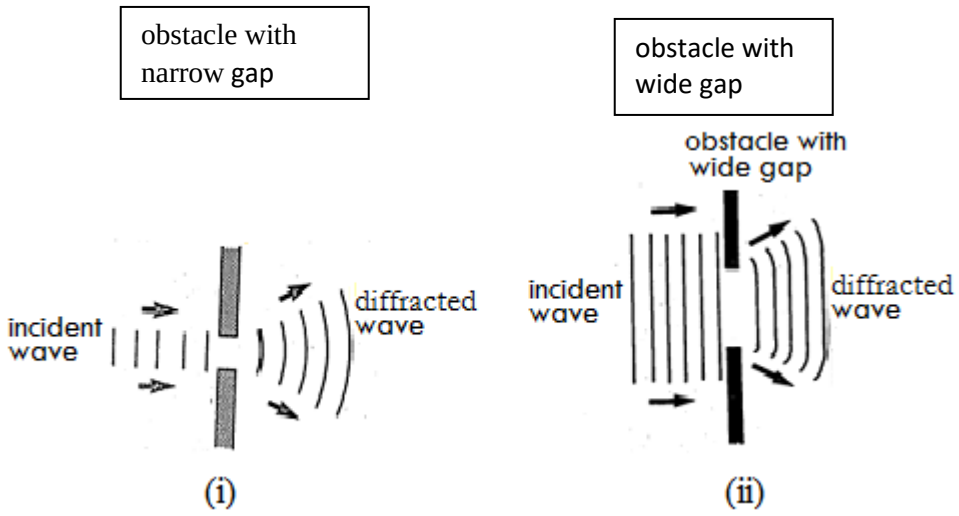
The question asked the candidates to state any two properties of electromagnetic waves. Many candidates got it correct. Some of the expected responses were: they are transverse in nature, they travel at the speed of light i.e. 300,000 km/s, they can travel in a vacuum and they carry no charge. Those who failed gave wrong responses like they are positively charged and can be ionised.

Section B

Question 11 a

The question required the candidates to explain the difference in the spreading of waves passing through a narrow gap and a wide gap with the aid of well labelled diagrams. The question was attempted by many candidates with a higher performance.

The expected response was that, waves passing through narrow gap refract to form a circular shape with a stronger diffraction while those through a wider gap diffract with a rectangular shape with weak or less diffraction just as shown in the **figure**.



However, some failed because they were not able to draw clear diagrams and give correct explanations due to poor mastery of the content.

Question 11 b

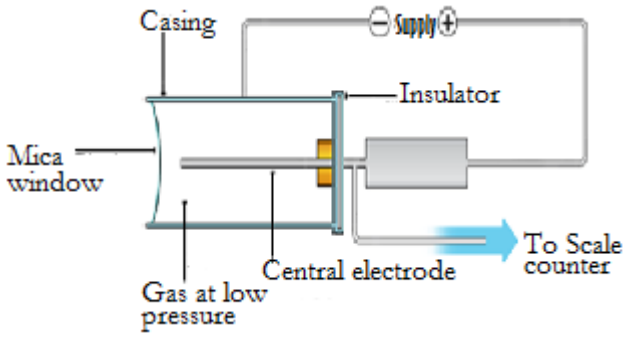
The question demanded the candidates to explain how Newton's first law of motion is applied when a car seat belt is in use. Few candidates got it correct. Candidates were expected to state that when brakes are applied on a moving car the moving car suddenly stops an unbalanced force is created in the car. The passengers however would want to continue moving at the original speed of the car. If the seat belt is used it holds back or applies an unbalanced force on the passenger. Some candidates failed because they explained using Newton's Third law of motion while other candidates explained about how the crumple zone helps to minimise the impact on the passengers during accidents while others felt the seat belts helps to prevent a passenger from vomiting.

Question 12 a

Candidates were asked to explain in terms of the kinetic theory a reason for an inflated balloon bursting when heated. A few candidates got it correct and the expected response was that when temperature of the gas inside the balloon increases, the molecules gain more kinetic energy and increase the gas pressure. The gas molecules thus strike/hit on the walls of the balloon more frequently and with a greater force. The increased gas pressure in the balloon causes the balloon to increase in volume or expand and eventually burst at weak point. Those candidates, who failed, could not logically explain as well as explain in terms of the kinetic theory as a result of poor mastery of the content.

Question 12 b

The question demanded the candidates to describe the way a Geiger – Muller tube works during the detection of radiations. A few candidates did well and the expected response was that when any ionising radiation enters the tube the gas molecules in the tube get ionised. The ions are then accelerated by the electric field so formed between the anode and cathode. This causes a pulse of electric current between the anode and cathode. The pulse of electric current is thus amplified and detected/measured by the scale counter/rate meter (see the figure below)



Candidates who failed, explained about the Spark counter or Cloud chamber instead of focussing on the demand of the question.

Question 13 a

Candidates were asked to explain how the n-type semiconductors can be designed using doping method. A few candidates got it correct. The expected response was that pure or intrinsic semiconductor e.g. silicon is combined with a pentavalent (Group 5) atom. The silicon has four valence electrons. This results into four of the new atoms' (pentavalent atom) electrons covalently bonded leaving one electron not taking part in the bonding. This unbonded electron is

free to move to the conduction band/lattice and requires little thermal energy to jump from the valence to the conduction band. The resulting semiconductor has more electrons as charge carriers hence referred to as n–type semiconductor. Those who failed, they only gave definitions of semiconductors while some wrote factors that affect their conductivity e.g. temperature, area and impurities.

Question 13 b

The question demanded the candidates to describe how a drinking straw helps in sucking the A few candidates got it correct. The expected response was that sucking through a straw reduces the air pressure inside the straw. Atmospheric pressure pushes on the surface of the liquid hence forcing/pushing it up into the mouth through the straw**.** Some failed because they described in general about the ability to drink using a straw in which they tried to explain about the difference between atmospheric pressure and the pressure in the lungs while other wrote the application of liquid pressure and how it helps in blood transfusion.

PAPER II (PRACTICAL)

Question 1

The question required candidates to describe an experiment that can be used to show that sound requires a medium for transmission. Many candidates attempted it with a higher performance. The candidates were expected to demonstrate skills in drawing scientific diagrams, setting out logical experimental procedures, comparison of experimental observations and drawing experimental conclusions. Most candidates were able to come up with a required diagram. Some candidates lost some marks on this skill because of being unable to use a relevant diagram that would support a vacuum environment. Most common of such irrelevant environments was the use of an open beaker. In terms of setting out of logical experimental procedures, a majority of candidates demonstrated a good mastery of the skill hence scored highly. Those that failed to obtain full marks in this question showed lack of skills in making of comparison of experimental observations as well as drawing experimental conclusions. On comparison of observations, the correct way was to ‘compare the observation when there was air with that of a vacuum’. On drawing experimental conclusions, the correct response was ‘ If sound is heard when there is air only, then sound requires a medium for transmission’ or If sound is heard when there is air, and is not heard when there is vacuum/ no air, then sound requires a medium for transmission. Those that missed the conclusion were providing theoretical conclusions like ‘Sound is heard when

there is air and not when there is a vacuum. Therefore, sound requires a medium of transmission' which was wrong. However, since the skills of drawing and experimental procedure had more marks compared with the last two skills that were tested in this question, majority of candidates performed above average in this particular question. Some of those that completely missed the question were describing how an electric bell works, which was wrong.

Question 2

The question required candidates to describe how the speed of an athlete can be determined using the given materials. The candidates were expected to demonstrate skills in setting out logical experimental procedures, drawing relevant experimental conclusions and proper use of relevant mathematical expressions. In this case they were supposed to determine the average by measuring the total distance and come up with the average time taken for the athlete to run over the distance. Then they were supposed to show that the average speed would be calculated using the formula:

$$\text{Average speed} = \frac{\text{Total distance}}{\text{Total time taken}} \ ,$$

Those who got the question correct expressed themselves mathematically e.g. on the determination of distance travelled, total time taken which was correctly obtained by difference, in addition to the correct expression for formula of average speed. Those that failed they misunderstood the meaning of the word '*athlete*' as revealed by some funny responses like ' Throw an athlete in the air', ' measure the athlete with a tape measure', ' Tie the athlete in a swinging pendulum', etc. which is a clear demonstration of a deficiency in content coverage.

Question 3

The question asked the candidates to conduct hands-on experiment on the effect of increasing load distance from the fulcrum on the magnitude of effort required to bring the system into equilibrium. The question was very popular as all candidates attempted it. The item demanded the skills of data collection, plotting of graphs, interpolation of data using graphs and interpretation of relationships between variables using graphs. Most candidates were able to collect relevant data as evident by the correct responses in the table of results. Those that failed, demonstrated lack of skills in measurements within data collection processes as some could record spring balance readings as high as 500N in some variable points. In terms of plotting of

graphs, fewer candidates showed a good mastery of the required skills. For those that struggled, although most of them were able to match ordered pair of points on the graph, most of these candidates were unable in coming up with a suitable scale and a line of best fit. The correct way of drawing a line of best fit is to even out the number of outliers (points falling off a graph line) on both sides the graph line. In terms of skills on interpolation as demanded in **Question 3 h (i)**, most candidates demonstrated suitable skills in interpolation of graphs. Those that missed this part were reporting approximated values instead of reporting the exact value falling on the given scale. Responses from the candidates showed that majority of them were able to interpret the graph by way of giving a relevant relationship between variables correctly as 'as distance of load from fulcrum increases, effort required to lift the load also increases; with the independent variable written first. Some also failed because they misinterpreted the term 'relationship'. For example, some candidates gave irrelevant responses such as 'they are against each other', they are different' and 'they are the same' etc. as relationship between the variables.

Question 4

The question demanded the candidates to conduct a hands-on experiment on the effect of thickness of a conductor on its electrical resistance. The question was very popular as all candidates attempted it with higher performance. The item demanded the skills of data collection, numerical skills in manipulating mathematical expressions, interpretation of relationships between variables using a table and determination of control variables in an experiment. Most candidates were able to collect relevant data as evident on the correct responses in the table of results. Those that failed demonstrated lack of skills in measurements within data collection processes as some could record voltmeter readings as high as 200V in some variable points. In terms of numerical skills, majority of candidates showed a good mastery of numerical skills in calculation of values of resistance in the table. Some candidates were using a wrong formula; Resistance = $\frac{Current}{Voltage}$ instead of $\frac{Voltage}{Current}$.

Majority of candidates were able to interpret the data correctly from the table of results although a good number of candidates struggled in determination of control variables in a given experiment as demanded in **Question 4 (h)** with some funny responses like gap XY was kept constant, independent variable was constant, etc. The correct response for this item was any of the following: length of wire, type of wire and temperature.

D. Recommendations to:

(i) Schools

Schools should:

- ensure adequate syllabus coverage, treating all topics equally.
- ensure use of variety of prescribed and recommended reference materials.
- give students regular hands-on experiences on experiments to enable then attain desired competencies in Physics.
- ensure that Science teachers have access to Chief examiners' Reports.

(ii) Ministry Of Education

The Ministry should:

- establish a Science Material Special Fund in schools as is the case with Textbook revolving Fund to ensure adequate supply of science materials in the schools
- recruit more qualified science teachers
- establish more professional development programs aimed at supporting practicing science teachers.
- establish learners' interactive workbooks containing several hands-on practical work activities to enhance learner's understanding of scientific inquiry.

(iii) Malawi Institute Of Education (MIE)

- MIE should let the prescribed and recommended books be revised frequently and enable possible corrections, amendments and improvement. e.g there are some Physics texts books which need to be revised and improved.